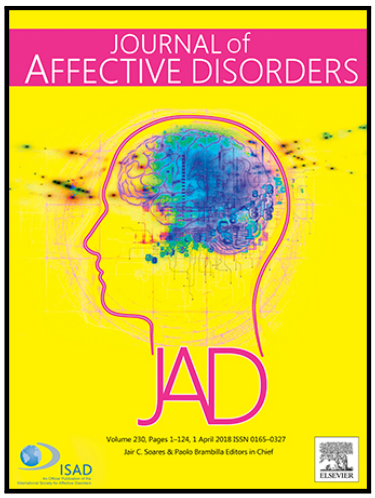

Bereavement or Breakup: Differences in Networks of Depression

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Highlights

- Patterns of depression can be linked to specific adverse life events
- Network analyses allow exploring differences in symptom relations after life events
- Differences in symptom patterns give rise to tailored treatment hypotheses
- Widowhood/separation are primarily linked to loneliness, followed by other symptoms

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Abstract

Background

Prior network analyses demonstrated that the death of a loved one potentially precedes specific depression symptoms, primarily loneliness, which in turn links to other depressive symptoms. In this study, we extend prior research by comparing depression symptom network structures following two types of marital disruption: bereavement versus separation.

Methods

We fitted two Gaussian Graphical Models to cross-sectional data from a Swiss survey of older persons (145 bereaved, 217 separated, and 362 married controls), and compared symptom levels across bereaved and separated individuals.

Results

Separated compared to widowed individuals were more likely to perceive an unfriendly environment and oneself as a failure. Both types of marital disruption were strongly linked to loneliness, from where different relations emerged to other depressive symptoms. Amongst others, loneliness had a stronger connection to perceiving oneself as a failure in separated compared to widowed individuals. Conversely, loneliness had a stronger connection to getting going in widowed individuals.

Limitations

Analyses are based on cross-sectional between-subjects data, and conclusions regarding dynamic processes on the within-subjects level remain putative. Further, some of the estimated parameters in the network exhibited overlapping confidence intervals and their order needs to be interpreted with care. Replications should thus aim for studies with multiple time points and larger samples.

Conclusions

The findings of this study add to a growing body of literature indicating that depressive symptom patterns depend on contextual factors. If replicated on the within-subjects level, such findings have implications for setting up patient-tailored treatment approaches in dependence of contextual factors.

Keywords: Depression, Divorce, Network Analysis, Bereavement, Marital Disruption

Bereavement or Breakup: Differences in Networks of Depression

1. Introduction

1.1 Marital transition and mental health

One of the most well-known wedding vows suggests a long-term perspective on a relationship, with death being the only cause for its termination: “Till death do us part.” Demographic data, however, suggest that the end of a marriage is not always marked by the death of a partner. Marital disruption, the termination of a marriage due to separation or divorce, has been well-established as a frequent life event. In the USA, the probability that a first marriage is still intact after 20 years has been calculated at approximately 52% for women and 56% for men aged 15–44 (Copen et al., 2012).

Both spousal loss and separation are associated with major psychological distress, increasing the risk of severe long-term detriments to well-being and health. One of the most frequent consequences of spousal loss and separation are mood-related disorders, and more specifically, depression (Sbarra, 2015; Wójcik et al., 2019). The Diagnostic and Statistical Manual of Mental Disorders 5 (DSM-5; American Psychiatric Association, 2014) characterizes depression through nine criteria, namely, depressed mood, diminished interest/pleasure, weight/appetite increase/decrease, insomnia/hypersomnia, psychomotor agitation/retardation, fatigue, feelings of worthlessness or inappropriate guilt, lack of concentration or indecisiveness, and suicidal ideation. The presence of at least five of the symptoms (at least one of which have to be either sad mood or anhedonia) qualifies for the diagnosis Major Depressive Disorder (MDD). Taking into account all possible combinations of sub-symptoms, this results in over 10,000 hypothetical symptom combinations for the same diagnosis, and empirical studies have observed that many of these are realized in patients with a diagnosis of MDD (Fried & Nesse, 2015; Zimmerman, Ellison, Young, Chelminski, & Dalrymple, 2015). Crucially, different life events have been associated with

differences in depressive symptomatology (Cramer, Borsboom, Aggen, & Kendler, 2012; Fried, Nesse, Guille, & Sen, 2015). Based on this finding, the present study uses a network approach to investigate whether the two types of loss introduced above are differentially related to depression symptoms.

1.2 The network perspective to depression following bereavement

The network approach to psychopathology conceptualizes symptoms and other factors of mental health as causally interacting entities (Borsboom and Cramer, 2013). Network analyses have been applied to the field of bereavement, through the study of depression and complicated grief symptoms (Robinaugh et al., 2016, 2014) and their interrelations (Djelantik et al., 2019; Malgaroli et al., 2018). Specifically, as discussed above, Fried et al. (2015) fitted several models to a dataset to compare elderly bereaved versus still-married participants. Loneliness was much more strongly related to spousal loss than other depression symptoms, and in turn was associated with a host of other symptoms. We aim to extend this finding to compare the effects of spousal loss to marital breakup.

1.3 Bereavement versus breakup

There are reasons to assume differences in the symptom dynamics of depression following spousal bereavement versus marital breakup. Wrzus, Hänel, Wagner, and Neyer (2013) classify widowhood as an expected life event, usually accompanied by a supportive social environment, especially after an initial phase of social withdrawal. Bereavement is predominantly associated with feelings of grief over the loss of the loved person, alongside a variety of related manifestations (Stroebe et al., 2017). While stigmatizing responses towards bereaved individuals with a diagnosis of prolonged grief disorder have been experimentally demonstrated (Eisma, 2018), conclusive evidence regarding the prevalence of stigmatization in spousal loss is scarce; a systematic review of social support in bereaved individuals found that most studies conducted on this issue face several methodological and sampling

limitations (Logan et al., 2018). In a previous network study, Fried and colleagues (2015) found that people who had lost a loved one primarily developed loneliness over other depressive symptoms; loneliness, in turn, was related to a host of other depressive symptoms. The authors speculated that loneliness might thus be a gateway symptom which prevention strategies for depression could focus on to disrupt relations with other symptoms following spousal loss.

While one can make similar predictions about loneliness following marital breakup (especially perhaps for those who did not initiate the separation, cf. Hewitt and Turrell, 2011), other symptoms of depression would seem likely to be important as well. Wrzus et al. (2013) noted that separation (specifically: divorce) can be especially stressful due to the reduction in a person's social network, through the partial loss of in-laws and spouse's friends. Given that breakup is associated with adverse interpersonal relationship experience (Sbarra, 2015), items representing the perceived negative opinions and social responses of others might thus be as or even more apparent, compared to loneliness. Measures of depression include relevant items; the CES-D (Radloff, 1977) items "I thought my life had been a failure" and "People were unfriendly" (in the following referred to as *failure* and *unfriendly*, respectively) thus arguably capture the experience of breakup better than bereavement.

Following these contrasts in marital transition, crucial differences in the nature of mental health-related difficulties could be expected: For bereaved individuals, one could argue that loneliness as a consequence of spousal loss (Fried et al., 2015) is accompanied with symptoms related to grief work. Separated individuals on the other hand are more liable to evaluate their life plan as a failure, with their social environment often compounding this due to lack of support and/or understanding (Wrzus et al., 2013).

1.4 The current study

We estimated network models and compared symptom levels following widowhood and separation, compared to a still-married sample and tested three hypotheses:

H1. CES-D sum-scores are higher among both bereaved and separated individuals compared to married individuals.

H2. Separated individuals show higher levels of *failure* and *unfriendly* compared to widowed individuals.

H3. Both loss types are primarily linked to *loneliness*, which in turn is associated with other CES-D symptoms.

A note on exploratory analyses. Network analysis at present is largely used to gain exploratory insight into multivariate dependencies. These structures can generate hypotheses about putative causal relations. To this end, we extend our investigation to interesting relations that have not been hypothesized. These exploratory analyses are distinguished from our confirmatory findings (the latter include the respective hypothesis in brackets). Most importantly, we are interested in how *loneliness* is differentially related to other CES-D symptoms, comparing bereaved with separated individuals.

2. Methods

2.1 Participants

We analyzed data from the Swiss project "Relationships in later life" (http://www.kpp.psy.unibe.ch/forschung/projekte/nccrlives/index_ger.html). In this project, information on marital transitions and related mental health components were collected over three waves (2012, 2014, and 2016). The Swiss Federal Statistical Office identified a random sample (stratified by gender, age, and marital status) of 6889 married, widowed, divorced and separated individuals aged 40 – 90. These individuals subsequently received letter mail with an invitation to the study and the paper-and-pencil questionnaire. Additionally, advertisements were placed on various platforms (radio, newspaper, and online). Participants

were informed regarding the purpose of the prospective longitudinal data-collection (changes and stability of relationships in later life). In total, data on 1276 married, 566 widowed, 721 divorced, and 250 separated individuals were collected, from which we derived two marital status sub-samples. A schematic overview of the sampling procedure in this study can be seen in Figure 1.

[Figure 1]

2.1.1 Widowed and separated individuals. We sampled widowed and separated individuals from all three waves, if they met two inclusion criteria: First, the loss/breakup occurred within two years prior to assessment, and second, the widowed/separated person did not have a new partner at the time of assessment.

The former criterion was chosen on the basis of two considerations: On the one hand, due to the way data was collected (time distance of two years in between waves), *extending* the time criterion to more than two years would mean that participants who experienced loss/breakup more than two years prior to wave 2 and 3 would be sampled multiple times (from several waves). On the other hand, *decreasing* time-intervals to less than two years would have led to rather low sample sizes in the present dataset. We therefore faced a trade-off between statistical power and capturing experiences in close approximation to the life event, and opted for a compromise of two years. We hope that future research will investigate effects of different time distances to the life event to capture both, adaptation over *longer periods* including more complex processes of loss and depression, as well as experiences *in close approximation* to the life event).

The second criterion was chosen to account for protective influences that a new partnership might have on an individual's grief (de Jong Gierveld, 2004). This resulted in 145 widowed and 217 separated individuals.

[Table 1]

2.1.2 Samples for network analysis. We see two main possibilities for constructing networks to tackle our research questions: a) adding married participants as controls/contrast to both the widowed and the separated sample, and estimating two networks for the respective samples (using a similar logic to Fried et al. 2015), or b) estimating three separate networks for the three groups widowed, separated and married. The main difference between these approaches is that the networks estimated in method a) allow us to include the life event as a node in the network, which is not possible for networks estimated in method b). This is because in method b), the samples are set up in a way that each participant experienced *the same life event* within one sample. The variable 'life event' thus has no variance, consequently making it impossible to estimate (partial-)correlations between the life event and other variables.

Since the focus of our analysis is to examine differences in how widowhood and separation are (differentially) related to depressive symptoms, we estimated two networks according to option a), while providing the networks resulting from the estimation method b) in the supplemental material (Figure S1). The networks estimated according to method b) can be relevant in focusing on structural differences of depressive symptoms within each sample, if relations to the life event are not of interest. Accordingly, we randomly sampled 362 married controls who did not previously experience spousal loss or separation/divorce, and constructed two samples that were then used to estimate the networks. The first sample consisted of the 145 widowed individuals introduced above combined with 145 married controls, the second sample of 217 separated individuals combined with the remaining 217 married controls. Table 1 compares demographic characteristics across the widowed, separated and married sample.

We decided to sample married controls randomly as opposed to making use of matching procedures, since several demographic variables of interest had many missing

observations. To ensure that estimated network structures were not dependent on the seed chosen to sample married controls, we repeated the sampling procedure four times with other random seeds, and correlated the adjacency matrices of the resulting network with the one discussed below. Correlations ranged from .89 to .92 for the widowed, and from .92 to .94 for the separated network, indicating that the network structures had high consistency for different compositions of the married sample.

2.2 Outcome measures

Depressive symptoms were assessed using the German short version of the Center for Epidemiologic Studies Depression scale (CES-D; Radloff, 1977; German: Allgemeine Depressions-Skala, ADS-K; Meyer and Hautzinger, 2001). Participants rated 15 items with respect to the frequency with which they occurred in the last week, with the four response categories "rarely or none of the time (less than 1 day)", "some or a little of the time (1-2 days)", "occasionally or a moderate amount of time (3-4 days)" and "most or all of the time (5-7 days)". The German version of the CES-D has been found to be reliable with Cronbach's Alpha between .89 and .92 (Hautzinger and Geue, 2016). In line with these findings, we obtained a Cronbach's alpha of .90 for our study sample. While the CES-D is used as a screening-tool and does not allow to determine diagnostic status, it provides useful information regarding our proposed differences in comparison to other scales. Specifically, the CES-D items "I thought my life had been a failure" and "People were unfriendly" are relevant to investigate the above discussed differences in social support and evaluation of one's life.

One major challenge in the extant network literature in psychopathology is that some items modeled in networks might measure the same construct (Fried & Cramer, 2017). This poses a problem for inferences because edges in network models should only be interpreted as putative causal relations if the nodes are indeed distinct entities. At present, there are no

clear guidelines to differentiate between a correlation that arises from items measuring *the same construct* and a correlation due to two items being related, but originating from *distinct constructs*. Since purely data-driven approaches cannot account for theoretical considerations, we combined items if they met two criteria. Items were combined if the items showed correlations of $r \geq .50$, and if the items could be understood to measure the same construct. Accordingly, we combined the items *mood*, *upset* and *depressed* into the new item *mood*, and *happy* and *enjoy* into the new item *happy*, resulting in 12 instead of 15 items. The final list of items is presented in the supplemental materials, Table S1. The item-pairs *depressed – concentration, concentration – exhausted, lonely – mood, lonely – depressed, sad – depressed, getgo – depressed, getgo – exhausted* and *lonely – sad* all exhibited correlations of $r \geq .50$, however, for the purpose of this paper, we understand them as theoretically separate constructs.

2.3 Statistical analyses

2.3.1 Symptom level comparison. Prior to the network analyses, widowed, separated and married individuals were compared with respect to differences in the item sum-score using a one-way ANOVA and post-hoc tests. Furthermore, overall differences with respect to specific symptoms were analyzed in a MANOVA and symptoms were examined individually with respect to group differences.

2.3.2 Network analysis. Following the group comparisons, we estimated two separate networks. Both networks consisted of the combined set of 12 CES-D items and one node to the life event (network 1: spousal loss versus marriage, network 2: marital breakup versus marriage). We estimated regularized partial correlation networks (Epskamp and Fried, 2018) based on Spearman's rank correlation, due to the ordinal nature of items. We chose Spearman correlations over polychoric correlations, since polychoric correlations led to highly unreliable parameter estimates; as explained elsewhere (Epskamp et al., 2018), this

can happen when the sample size is small, items have few response options, and are considerably skewed. To account for potential spurious relations, we used a regularization approach with the tuning parameter γ (specifying the level of sparsity) set to 0.5 (Foygel and Drton, 2010). Recent literature suggests that non-regularized networks might be preferable in some cases, especially for very large sample sizes (Williams et al., 2019). Since this is not the case for our sample, we present the non-regularized partial correlation networks in the supplemental material (Figure S2).

It is good practice to determine the accuracy and stability of estimates and inferences in the networks. To this end, we conducted the stability/accuracy routine using the *bootnet* package in R described elsewhere (Epskamp et al., 2018). The networks were estimated using the *bootnet* and the *qgraph* package (Epskamp et al., 2012). Additionally, we compared the two networks using the *NetworkComparisonTest* (van Borkulo et al., 2015). Since this procedure might yield biased results if the network samples are unequal in size (van Borkulo et al., 2017), we additionally correlated the weight matrices to obtain a measure of similarity, and subtracted the weight matrices to examine the largest absolute differences between edge weights.

Contrary to many network analyses conducted in the field of psychopathology, we did not calculate centrality measures for our networks. Most centrality measures are metrics based on summarizing edge weight information in respect to a given node, degree centrality for instance is calculated by summing all absolute edge weights going into a node. Our networks are composed of both, CES-D items and a node coding a life event, consequently making the interpretation of centrality measures as indicative of central to the network *of symptoms* problematic. This is because centrality metrics in our case would favor items that exhibit large relations to the life event over items that are unrelated to the life event. For that reason, we focused on comparing specific edges rather than centrality measures.

3. Results

3.1 Symptom level comparison

3.1.1 Sum-Score and diagnosis of depression. Widowed (n = 145), separated (n = 217) and married (n = 362) individuals differed in their overall CES-D sum-score, $F(2, 609) = 52.93$, $p < .001$, Cohen's $f = 0.34$. More specifically, sum-scores of married individuals ($M_{mar} = 6.67$, $SD_{mar} = 6.07$) were lower than those of widowed individuals ($M_{wid} = 11.65$, $SD_{wid} = 6.72$; $t(194.50) = 6.98$, $p < .001$, Cohen's $d = 0.78$, CI [3.58, 6.39]) and separated individuals ($M_{sep} = 13.47$, $SD_{sep} = 9.91$; $t(293.48) = 8.62$, $p < .001$, Cohen's $d = 0.83$, CI [5.24, 8.35]), but the widowed and separated groups did not differ from each other ($t(306.52) = 1.93$, $p = .055$, Cohen's $d = 0.21$, CI [-3.66, 0.04]), supporting our first hypothesis (H1). While the CES-D does not allow for determining diagnostic status, prior psychometric analyses (Lehr et al., 2008) suggested a score of 18 for a putative diagnosis. Following this cutoff, 6.04% of the married, 17.95% of the widowed and 29.95% of the separated individuals met the screening criterion of the scale.

3.1.2 Differences in specific symptoms. A MANOVA revealed overall differences between widowed (n = 145) and separated (n = 217) individuals with respect to specific CES-D items, $T^2(12, 301) = 4.91$, $p < .001$. In particular, as can be seen in Figure 2, differences emerged only for specific symptoms.

As hypothesized (H2), and after accounting for multiple-testing using Bonferroni-correction, separated individuals showed higher levels of *failure* ($t(343) = 5.56$, $p < .001$, Cohen's $d = 0.58$, CI [.27, .57]) and *unfriendly* ($t(343) = 3.59$, $p < .001$, Cohen's $d = 0.36$, CI [.09, .30]) compared to widowed individuals. Furthermore, there were differences for the symptoms *afraid* ($t(345.98) = 3.17$, $p = .002$, Cohen's $d = 0.33$, CI [.10, .41]; separated > widowed) and *mood* ($t(319.35) = 3.03$, $p = .003$, Cohen's $d = 0.33$, CI [.09, .43]; separated > widowed).

Some other symptoms indicated significant differences between separated/widowed individuals (*exhaust*, $t(318.96) = 2.78$, $p = .006$, Cohen's $d = 0.30$, *CI* [.08, .45], separated > widowed; *sleep*, $t(321.96) = 2.04$, $p = .043$, Cohen's $d = 0.22$, *CI* [.01, .38], separated > widowed; *happy*, $t(281.39) = 2.60$, $p = .010$, Cohen's $d = 0.28$, *CI* [.07, .47], separated > widowed), however these did not remain significant after controlling for multiple testing. Given that some of these p-values were close to the traditional significance threshold of 5%, we want to call for caution in interpreting these effects as either clear positive or negative effects (Amrhein et al., 2019); more conclusive evidence will require replicating our study.

[Figure 2]

3.2 Network analysis

3.2.1 Network accuracy and stability. Graphical results of the stability and accuracy analysis can be found in the supplemental materials (Figure S3-S5). In general, the edge weights exhibit rather large confidence intervals, and some of the lower absolute edge weights do not differ significantly from other edges, indicating that the *order* of edges should be interpreted with some caution.

3.2.2 Network inferences. Figure 3 shows the estimated networks for the widowed/married (a, left) and the separated/married (b, right) sample.

Widowhood. As hypothesized (H3), and in line with prior findings of Fried et al. (2015), experiencing spousal loss was primarily associated with *loneliness* (partial correlation of $r = .30$), and additionally with *sadness* ($r = .26$). In turn, *loneliness* was linked to several CES-D symptoms (sorted by decreasing partial-correlation): *talk* ($r = .17$), *getgo* ($r = .16$), *mood* ($r = .11$), *afraid* ($r = .09$), *happy* ($r = -.06$), and *failure* ($r = .06$). In contrast to Fried et al. (2015), this analysis additionally revealed a strong direct relation between spousal loss and *sad* ($r = .22$) and weaker associations with *unfriendly* ($r = -.01$) and happy ($r = -.01$).

***Separation*.** As hypothesized (H3), and similar to the widowed network, separation was also strongly linked to *loneliness* (r = .33). *Loneliness* was in turn associated with other CES-D symptoms (sorted by decreasing partial-correlation): *sad* (r = .29), *failure* (r = .16), *mood* (r = .14), *talk* (r = .10), *happy* (r = –.07), *getgo* (r = .04), *unfriendly* (r = .04), and *exhausted* (r = .01). Next to *loneliness*, this network also exhibited somewhat weaker direct relations to the life event: *sad* (r = .10), *getgo* (r = –.08), *unfriendly* (r = .04), and *happy* (r = .02).

[Figure 3]

3.2.3 Network Comparison. To compare the networks globally, we first calculated the correlation of the adjacency matrices to obtain a measure of similarity, and second conducted the *NetworkComparisonTest*. The correlation between the adjacency matrices was r = .75, indicating that overall, the two network structures were largely similar. The *NetworkComparisonTest* revealed a significant result for the global invariance test (p = .005), indicating that there were some differences in the overall structure between the networks.

Of specific interest for our hypotheses (H3) was the extent to which *loneliness* following the two life events was differentially related to other CES-D symptoms. In an exploratory analysis, we investigated for which edges the two network structures showed the maximum difference, through subtracting their weight matrices. We visualized the largest absolute differences between edges in a network (Figure 4). The largest absolute differences between estimates were obtained for the edges *happy – mood* (Δ_r = .15), *exhaust – concentration* (Δ_r = .15), *afraid – sad* (Δ_r = .15), *getgo – concentration* (Δ_r = .13), *separation/widowhood – sad* (Δ_r = .12), *afraid – unfriendly* (Δ_r = .12), *lonely – getgo* (Δ_r = .12), *lonely – failure* (Δ_r = .11), *sad – failure* (Δ_r = .11), and *getgo – failure* (Δ_r = .11). With respect to our hypotheses (H3), differential associations with *loneliness* could be found to *failure* and *getgo*.

[Figure 4]

4. Discussion

Different life events may lead to different depressive symptoms, not only in overall quantity — some life events have more severe consequences than others — but also in quality. Since episodes of major depressive disorder are often preceded by severe stress or adverse life events (Hammen, 2005), the idea that different life events lead to different symptom profiles could explain a large part of the dramatic heterogeneity of depression symptoms (Fried et al., 2015; Zimmerman et al., 2015).

To our knowledge, this is the first study to investigate potential differences in depressive symptomatology between spousal loss and marital breakup by comparing symptom profiles and modeling the relationship between life events and symptoms via network models. We showed that one of the main differences between the two life events is a stronger feeling of experiencing an *unfriendly* environment and oneself as a *failure* within separated compared to widowed individuals. This finding is consistent with literature regarding consequences of the reduction in social network following separation and its effect on the individual's psychosocial well-being (Wrzus et al., 2013).

The network of bereaved individuals is largely consistent with previous findings of Fried et al. (2015), indicating that spousal loss is primarily connected to *loneliness*, in turn connecting to other depressive symptoms. Additionally, we found a strong link between spousal loss and *sadness*. The present study extends this finding to a different type of marital disruption; similar to spousal loss, marital breakup was also primarily linked to *loneliness*. Overall, the two networks showed largely similar structures, as indicated by a large correlation between their weight matrices.

In an exploratory analysis, we investigated the largest differences in edges between the two networks. Experiencing oneself as a *failure* revealed a stronger connection to

loneliness in separated compared to widowed individuals. For widowed individuals, we obtained stronger links for *lonely – getgo*, *getgo – exhaust*, and *getgo – concentration*. Keeping in mind the exploratory nature of this analysis, these findings give rise to two hypotheses: 1) *Loneliness* in separated compared to widowed individuals is more strongly associated with symptoms related to the normative evaluation of the life event (stronger relation of *loneliness* with experiencing oneself as a *failure*), and 2) *loneliness* in widowed compared to separated individuals is more strongly associated with symptoms related to the person's level of activity and cognitive capacities (stronger relations of *loneliness* with *getting going*, and *getting going* with *exhaustion* and *concentration*).

4.1 Implications for future research and clinical practice

In line with previous research (Cramer et al., 2012; Fried et al., 2015), our study provides further evidence of the importance of contextual information in explaining depressive symptom patterns. In clinical practice, this could provide important information in conceptualizing a patient's case, in understanding the etiology of depression, and in identifying potential treatment targets. This study indicates that the main difference in widowed compared to separated individuals might be characterized through a) differences in the *intensity* of specific symptoms (i.e., experiencing oneself as a *failure* and an *unfriendly* environment), and b) differences in *specific relations* to for example loneliness (e.g., *failure* and *get going*). These findings can help tailoring treatment approaches to characteristics of a given life event.

For both groups, prevention strategies targeting *loneliness* might be promising. For widowed and separated individuals specifically, one could try to disrupt relations between loneliness and other symptoms, if these can be replicated in other work. For instance, this study suggests that separated individuals would additionally benefit from learning that experiencing loneliness does not mean that their life plan is a failure (i.e., disrupting the

association between *loneliness* and *failure*), and widowed individuals could benefit from a stronger focus on helping them "getting going", for instance through behavioral activation (Papa et al., 2013).

4.2 Limitations

The results of this study must be interpreted in the light of some limitations. First, we analyzed cross-sectional data, any conclusions regarding dynamics remain thus putative. Further, the time-scale on which depressive episodes unfold may differ between participants, depending on the complexity of their depressive patterns. In a follow-up study, it would be important to include several time points to aim to estimate Granger-causal relations between life events and symptoms, and test effects of varying time-distances to the life events of interest.

Second, as became evident in the accuracy and stability analysis, many parameters are estimated with at best moderate precision. Our study faced a trade-off between sample size and the time passed since the critical life event, and we opted for a compromise of less than two years. We hope to replicate our finding in larger datasets of bereaved and separated individuals—once these become available—which will allow for stricter screening. This would also allow us to differentiate between potentially meaningful subgroups, such as initiators and non-initiators of separation (Hewitt and Turrell, 2011).

Third, separated individuals were significantly younger widowed individuals in this study. This might be considered a potential confound and limit the extent to which results can be generalized to other age groups. Demographic data (Copen et al., 2012) suggest that separation is indeed more prevalent among younger individuals, whereas elderly individuals are more likely to experience spousal loss compared to separation. The precise role of age in expressing specific symptoms thus remains a topic for future research.

Fourth, when applying network analyses to psychological scales, the choice of the scale and the topological overlap of its items might drastically influence the structure of the resulting network (Fried & Cramer, 2017). In the present dataset, we identified variables that could have been potentially relevant to add to our network investigation, more specifically contextual information regarding the cause of death in widowed participants, reasons for separation, and the Prolonged Grief Disorder-13 (PG-13; Prigerson et al., 2009) tool, however, these variables have unfortunately not been assessed at all three waves, and therefore were not suitable to be included in our analyses. Since reactions to loss experience have been linked to these specific symptoms of Prolonged Grief Disorder (PGD; Prigerson et al., 2009), we encourage to include such variables in future studies. Furthermore, since the network structure is based on partial correlations, excluding or combining items will lead to different network structures. This is why we, unlike most prior studies in the field, decided to thoroughly study item content, and modified the constructs under investigation based on a thresholding rule. However, this issue needs more attention from both clinical theories and empirical research, and decisions should in the best case be guided by both statistical tests and theoretical considerations.

Lastly, we used the CES-D for this analysis. The CES-D contains the items *loneliness* and experiencing oneself as a *failure*, which were important for our research questions. On the other hand, it is a screening tool for depression but is not used for the actual diagnosis of depression according to the DSM-5 (American Psychiatric Association, 2014), and differs considerably from other depression scales in terms of content (Fried, 2017). It would thus be interesting to model a broader range of depressive symptoms in future studies.

5. Conclusions

This study provides further evidence for the relation between specific adverse life events and different symptom patterns of depression. Network models are a promising tool in

understanding these differential relations, and can be used to compare spousal loss with marital disruption in this regard. A better understanding of these differences can in turn help in tailoring interventions to specific contextual factors.

Approval of authors

All authors have seen and approved the final version of the manuscript being submitted. The article is the authors' original work, hasn't received prior publication and is not under consideration for publication elsewhere.

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Author's contributions

MS and PP developed the study concept; with them, EF and HS derived the hypotheses and empirical testing procedure. PP and SS had collected the data as part of a larger project awarded to PP. JB and EF conducted the statistical analyses and drafted the manuscript, with substantive expertise from PP, SS, HS, ME, and MS. All authors contributed to revisions of the manuscript and approved the final version for submission.

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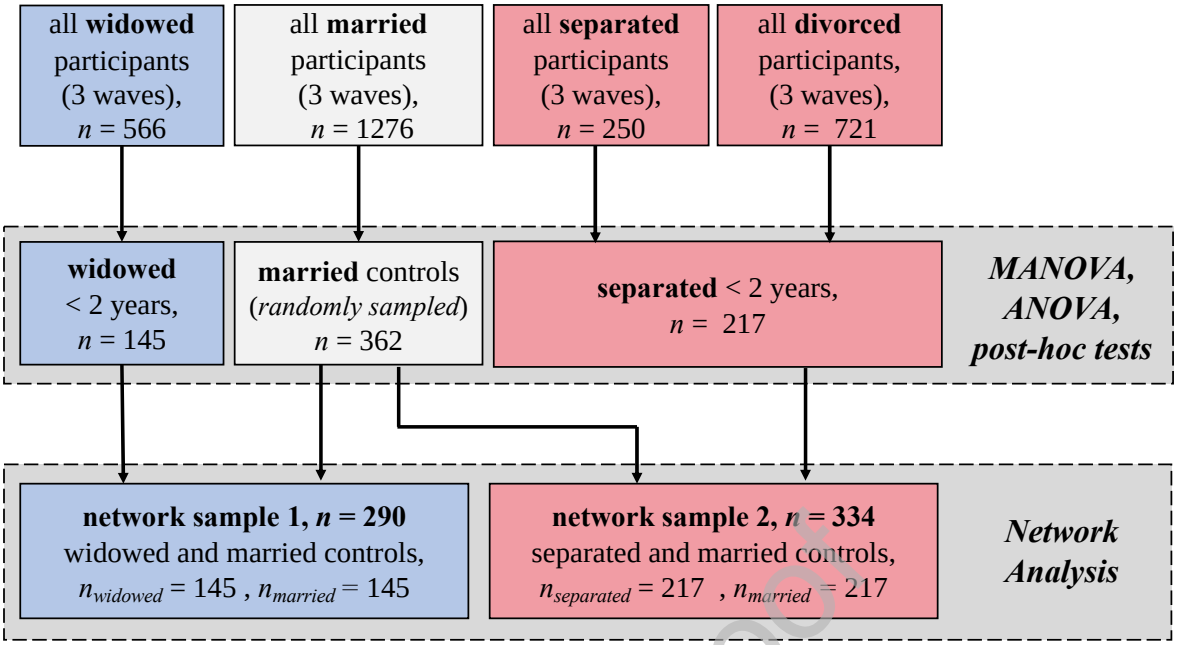

Figure 1. Schematic set-up of the samples and analyses used in this study. Inclusion criteria for separated/widowed individuals were a) a maximum time-distance to the respective life event of two years, and b) that the participant was not living in a new partnership. Married controls were randomly sampled from the pool of married participants. In order to be able to model the loss-type in the networks, an equal amount of married controls was added to both samples.

Table 1

Demographics of the widowed, separated and married sample.

	Widowed < 2 years, *n* = 145		Separated < 2 years, *n* = 217		Married controls, *n* = 362		Comparing widowed against separated sample		
	M	*SD*	*M*	*SD*	*M*	*SD*	Difference tests	Significance	Effect size, confidence interval
1. Gender, (% female)	79.31	-	76.04	-	52.76	-	$X^2(1) = 0.53$	$p = .466$	$w = 0.001$
2. Age	71.80	11.90	51.88	8.43	64.69	13.64	$t(238.72) = 17.44$	$p < .001$***	$d = 1.93$, *CI* [17.67, 22.17]
3. Duration of marriage (years)	16.58	9.97	21.86	11.03	11.52	6.72	$t(12.54) = 1.78$	$p = .100$	$d = 0.50$, *CI* [-1.17, 11.73]
4. Time since separation (months)	11.95	7.29	11.23	7.20	-	-	$t(306.15) = 0.93$	$p = .352$	$d = 0.10$, *CI* [-2.26, 0.81]
5. CES-D sum score	11.65	6.72	13.47	9.91	6.67	6.07	$t(306.52) = 1.93$	$p = .055$	$d = 0.21$, *CI* [-3.66, 0.04]

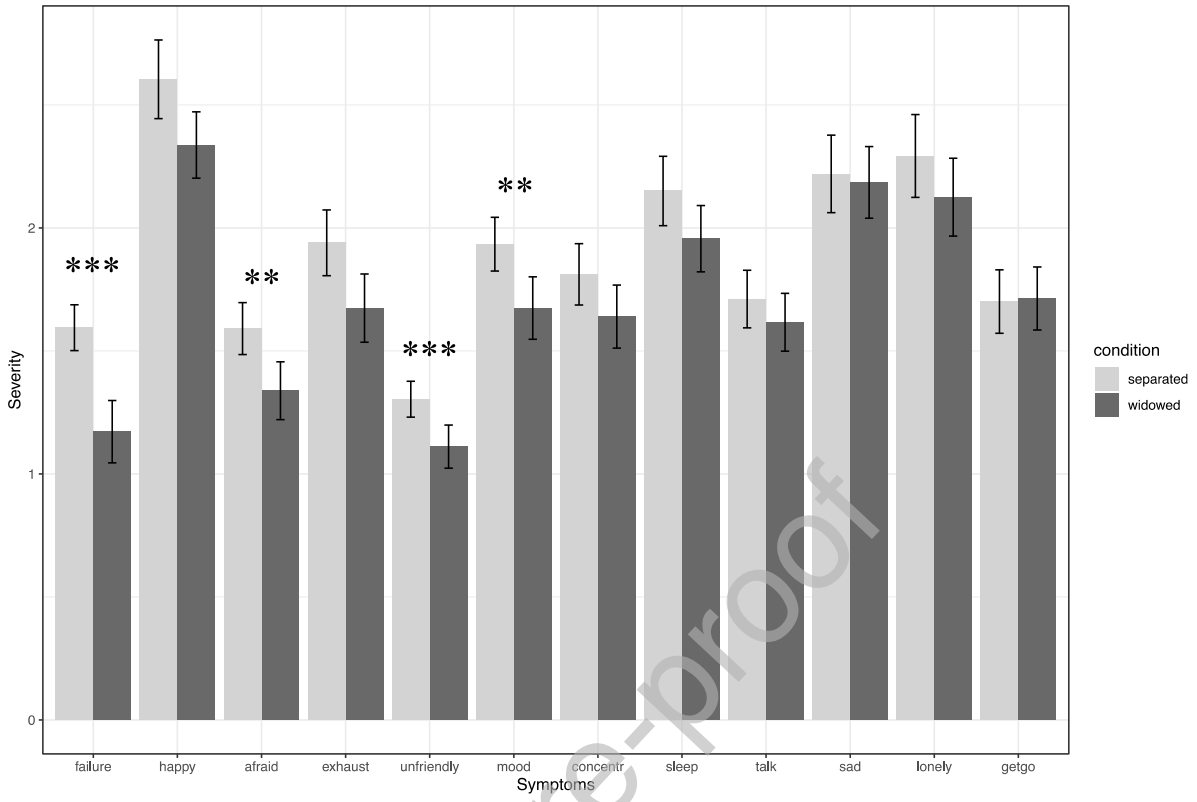

Figure 2. Post-hoc comparisons for all CES-D symptoms between separated and widowed individuals, sorted by decreasing mean differences. 95% confidence intervals are indicated. Note that we only indicated significance levels for items that were significant after correcting for multiple testing using the Bonferroni method.

*** significant at .001; ** significant at .01; * significant at .05.

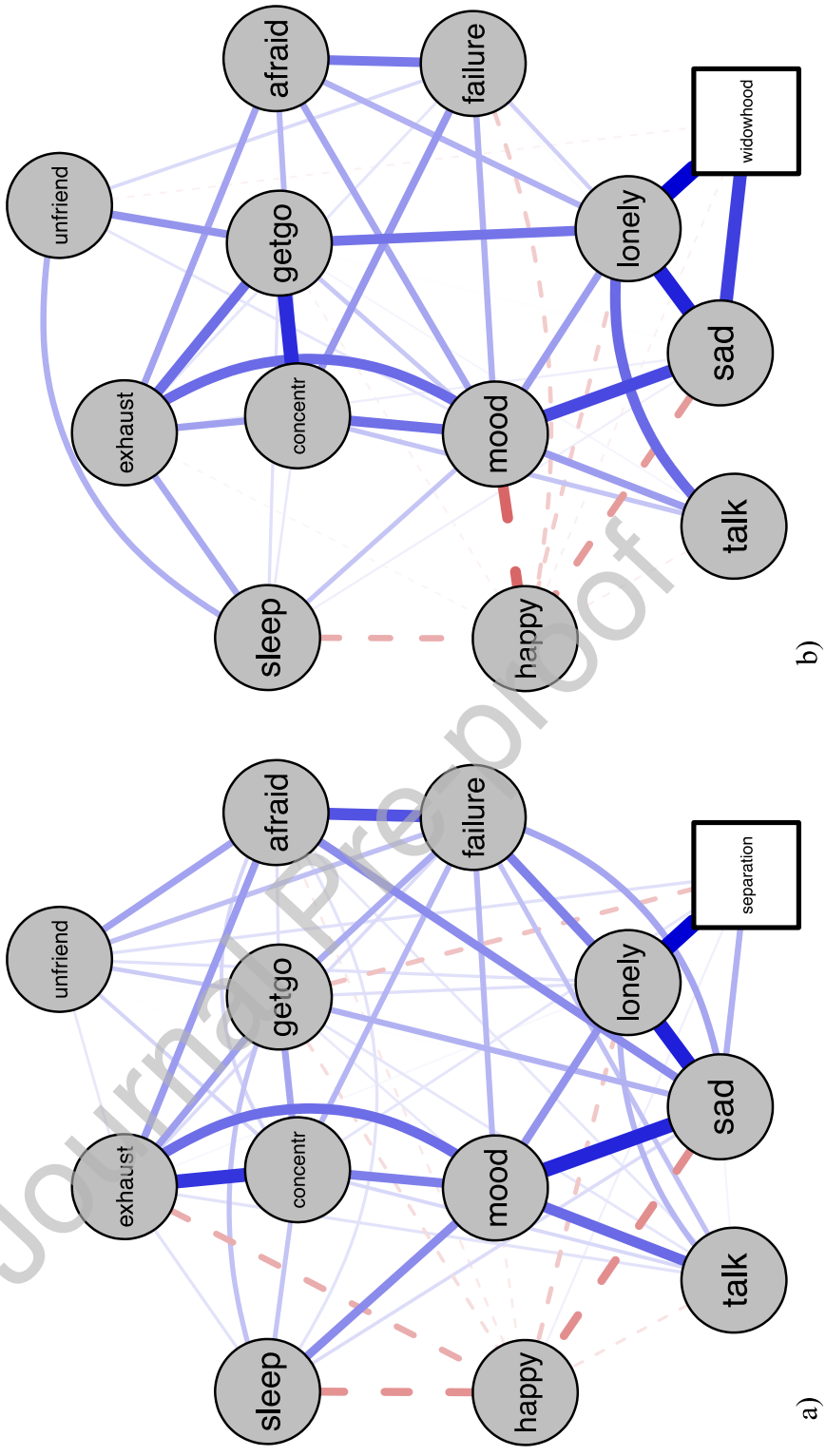

Figure 3. Regularized partial correlation network of the combined set of CES-D symptoms and spousal loss (a, 145 widowed individuals and 145 married controls) and marital breakup (b, 217 separated individuals and 217 married controls). Solid blue lines represent positive edges, dashed red lines represent negative edges.

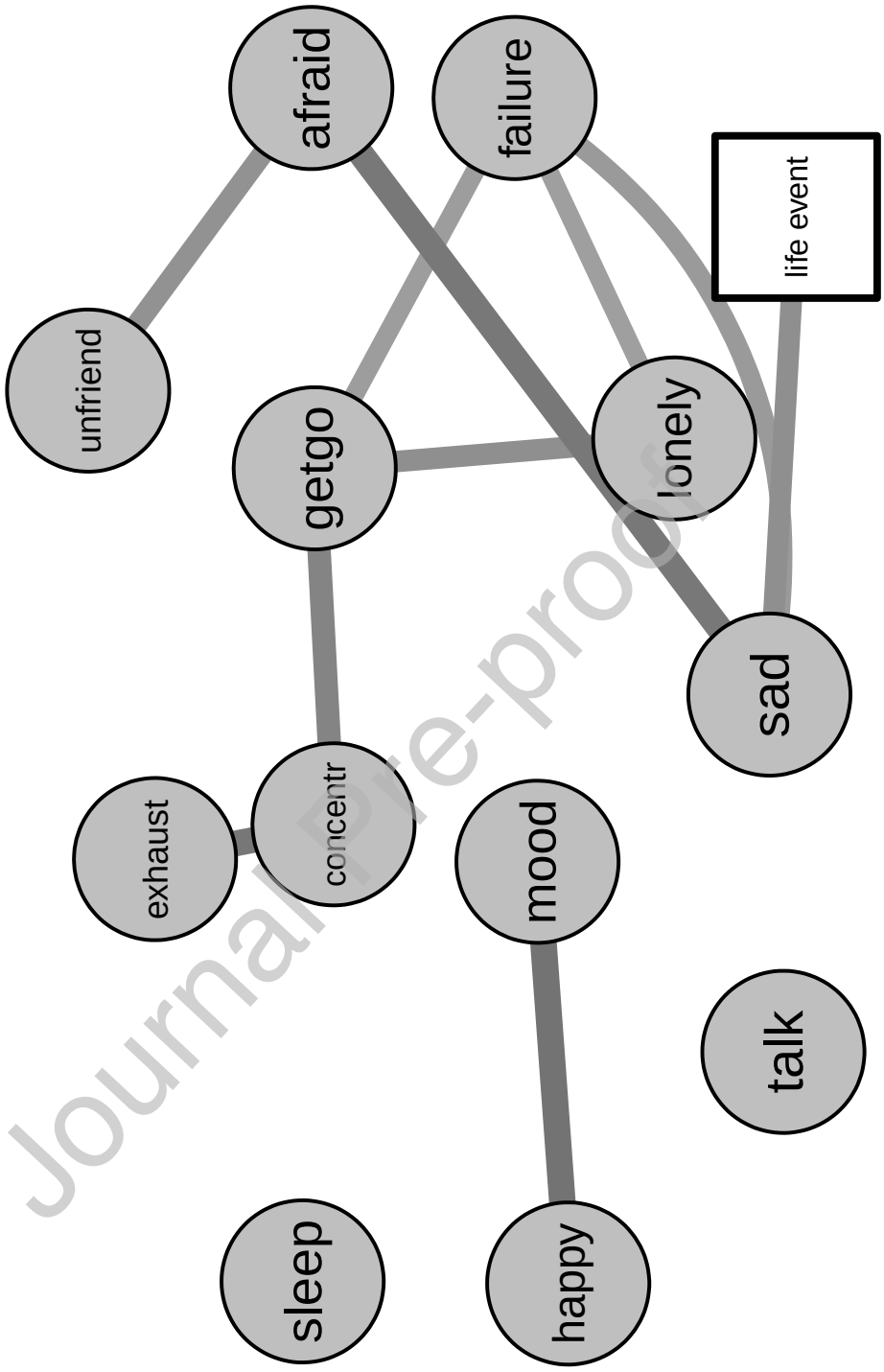

Figure 4. Network indicating the ten largest absolute differences in edge weights for the widowed network compared to the separated network, based on the difference scores of the respective weight matrices.